We Have the Spaceship; But Where's the Start Button: Human Engineering Issues in the Age of Long Duration Space Exploration

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Conclusion

- There's a lot of work left to do.
- Imminent hazards exist that must be researched and mitigated.
- The clock is ticking.

Instituting design principles into the basic architectures that will take us to and shelter us on distant bodies **must be done** within the next few years.

Long Duration Space Exploration Issues

- Gravitational Adaptation
- 2-D to 3-D Movement Adaptation
- Everything's a Handle
- Exercise Posture
- Space Ergonomics

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Gravitational Adaptation

- Crew have a history of reverting to micro-gravity while on Earth.
- A mission to Mars can have a cycle of 9 gravitational environments.
- Will the crew maintain gravitational adaptation for menial tasks?
- Cues specific to an environment can constantly "remind" the crew which gravity they're operating in.

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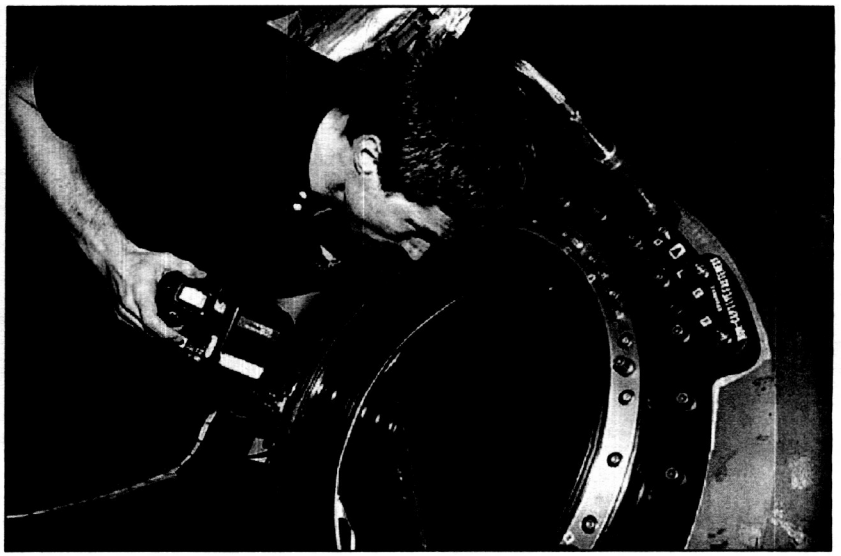
2-D to 3-D Movement Adaptation

- Crew switches to 3-D movement within 1-3 days.
- NASA operation planners allow for this adaptation to make the most efficient use of crew time and capabilities.

- Hardware designers typically do NOT design for this capability and lose any efficiency gains 3-D movement would allow.

Everything's a Handle



- Micro-gravity corollary – "When in need, everything's a handle."
- Optical Quality Window Vacuum Jumper
- If it looks like a handle, feels like a handle, and acts like a handle, then it is a handle.
- Form Follows Function vs. Function Follows Form

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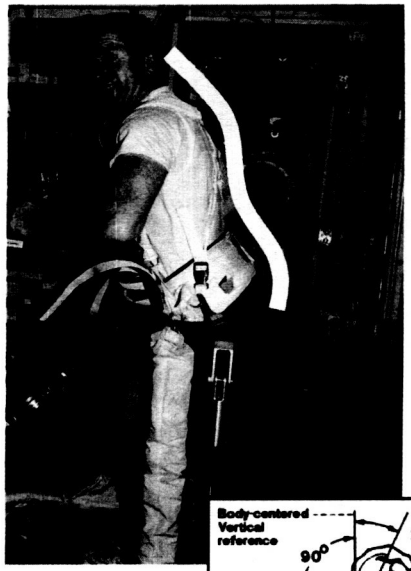
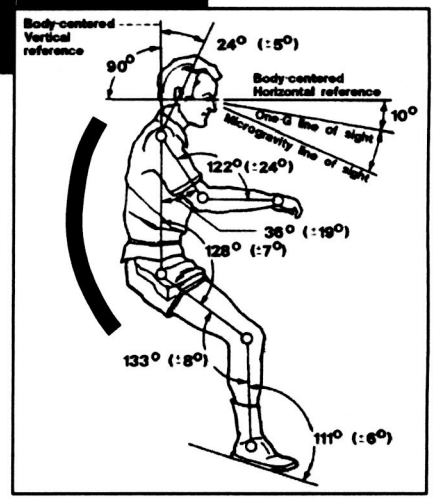
Exercise Posture

- Proper exercise posture on Earth includes a healthy S-curve.
- The classic micro-gravity Neutral Body Posture places the spine in a C-curve.
- Will micro-gravity work and exercise degrade a healthy S-curve?
- An S-curve orthotic could aid in maintaining a healthy S-curve.





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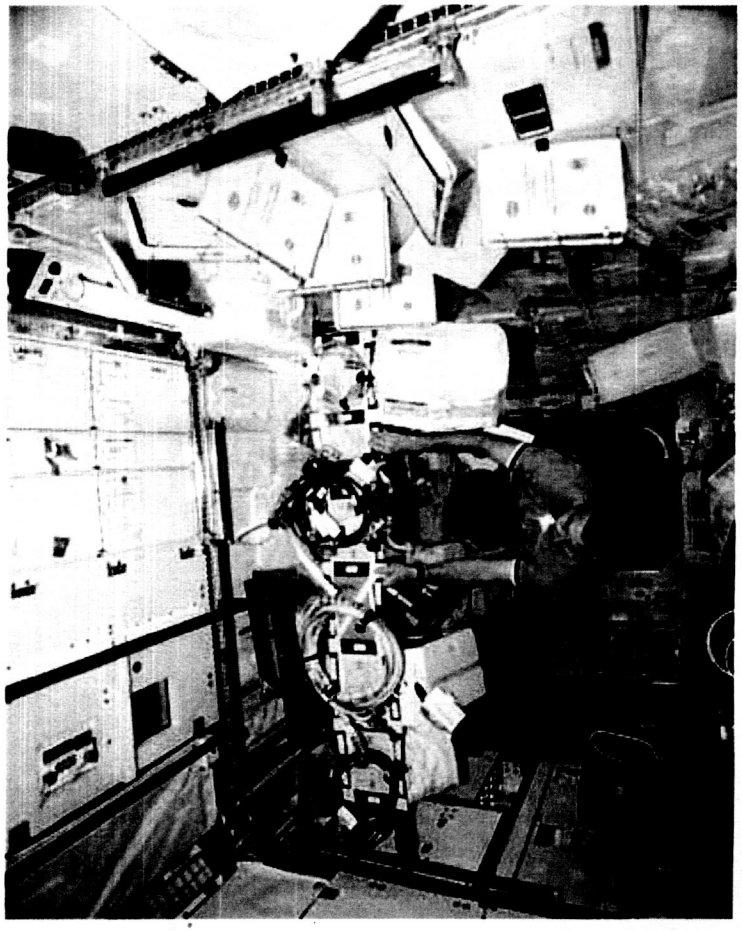
Space Ergonomics

- Current space hardware is typically designed from a technical standpoint.
- A systematic approach stemming from the operation and human-machine interface should be used.
- PERS – a success story.



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